Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

July 10, 2014

Dr. Rupak Biswas – Project Manager
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

Upgraded hyperwall System Will Increase Visualization & Data Exploration Capabilities

- The HECC Supercomputing Systems team installed the next-generation hyperwall system to replace the hyperwall-2, which has been in operation since 2008.
- The upgraded system has 128 compute nodes containing 256 Ivy Bridge processors, 64 gigabytes of random-access memory, and NVIDIA GeForce GTX 780 Ti graphics cards.
- Compared to the hyperwall-2, the new system provides 3 times the peak processing power, 4 times the memory, and nearly 3 times the interconnect bandwidth.
- The system was connected with the Pleiades InfiniBand fabric without impacting users.
- The new configuration simplifies system maintenance activities by leveraging the Pleiades management infrastructure.
- The Visualization team continues the upgrade process by porting applications and testing system functionality.

Mission Impact: The next-generation hyperwall will enable NASA scientists and engineers to more effectively visualize and explore even larger datasets produced using HECC supercomputing resources.

HECC's new hyperwall compute nodes are connected to a 128-screen tiled LCD wall arranged in an 8x16 configuration. The display measures 23-ft. wide by 10-ft. high. Each of the 128 nodes can display, process, and share data–allowing a single image to be shown across all screens, or myriad configurations of data to be shown in selected "cells."

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Sciences Corp.

New hyperwall Application Allows Exploration of 1/48 Degree ECCO Dataset

- The HECC Visualization team has written the first version of a hyperwall application for visualizing the results of a 1/48-degree, 3 petabyte (PB) simulation for the Estimating the Circulation and Climate of the Ocean (ECCO) project.
  - The 3 PB dataset is the largest produced at the NASA Advanced Supercomputing (NAS) facility to date.
  - Resolution of the ocean surface is so high in the simulation that it can only be displayed on the full, 128-screen hyperwall.
- The application's key feature is its ability to use MPEG-compressed, pre-computed visualizations to compress the data 25:1, which reduces the required bandwidth to a manageable amount.
- ECCO scientists can examine different ocean depths and scalar values by selecting a different MPEG animation in the application interface.
- After interacting with the application during a recent visit to the NAS facility, ECCO co-investigator Dimitris Menemenlis, NASA Jet Propulsion Laboratory, was eager to explore more of the dataset. "I should have stayed overnight. I will have to come back with Chris [Hill, co-investigator]," he said.

Mission Impact: Custom applications developed by HECC visualization experts enable Earth scientists to see their ocean simulation results at full resolution and to better understand the features in the output data.

At left, Dimitris Menemenlis, co-investigator on the Estimating the Circulation and Climate of the Ocean (ECCO) project, with HECC visualization lead Chris Henze, use a new application running on the hyperwall-2 to examine ocean velocity from a 1/48-degree ECCO simulation. Here, they examine water velocity far below the ocean surface, so no data appears near shorelines, shown in red.

POCs: David Ellsworth, david.ellsworth@nasa.gov, (650) 604-0721, NASA Advanced Supercomputing (NAS) Division, Computer Sciences Corp.; Chris Henze, chris.henze@nasa.gov, (650) 604-3959, NAS Division

HECC Passes Voluntary Protection Program Audit With High Marks

- On June 19, NASA Ames staff, along with the HECC Facilities team, conducted a Voluntary Protection Program (VPP) audit, inspecting every computer room and most offices in the NAS facility's two buildings.
- Auditors found that all the inspected areas adhere to strict federal and NASA safety mandates.
- In addition, auditors identified two best practices:
  - Bring students along on the audit. Auditors felt that raising safety awareness for people who are new to these types of environments is crucial to maintaining a safe workplace.
  - Strap heavy equipment (that is waiting to be excessed) to the wall. This action prevents equipment from falling and blocking egress in the event of an earthquake.
- With 200 people co-located with high voltage, water, and heavy equipment, safety and safety awareness is of utmost concern. The HECC staff at the NAS facility takes safety very seriously.

Mission Impact: At NASA, safety is the first priority. Passing the Voluntary Protection Program safety audit demonstrates that the HECC Project treats safety with the utmost importance.

A row of the latest SGI Ivy Bridge racks installed as part of the recent Pleiades supercomputer upgrade. Safely installing and maintaining these systems requires much planning and coordination. HECC Facilities staff work with every affected team to ensure systems are up and running efficiently and without incident.

POCs: Mark Tangney, mark.l.tangney@nasa.gov, (650) 604-4415, NASA Advanced Supercomputing (NAS) Division; Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NAS Division, Computer Sciences Corp.

Security Team Expedites Deployment of Java 7 Update 55

- On May 1st, 2014, the Office of the Chief Information Officer issued a Mitigation Action Recommendation (SOC-MAR-2014-0012), instructing all information system owners to expedite the deployment of Java 7 Update 55.
- The HECC Security team took immediate action to identify vulnerable systems and work with system owners to mitigate the threat posed by vulnerabilities in the Java platform.
  - Identified vulnerable systems within three hours of MAR notification.
  - Immediately notified system administrators and instructed them to patch vulnerable systems.
  - Used custom, in-house developed security tools to monitor progress.
  - Patched the majority of HECC systems within two weeks.
  - Submitted NASA Information Technology Waivers for systems that could not be patched due to their mission-critical nature.
- There was no indication that the Java vulnerabilities had been exploited prior to being patched.
- HECC security staff are responsible for monitoring real-time network activity at the NAS facility. System monitoring capabilities remained active throughout the patching process.

Mission Impact: Through rapid identification and patching of vulnerable systems, HECC security experts are able quickly mitigate the risk to NASA's critical high-end computing resources.

Java 7 Update 55 was deployed on all vulnerable HECC systems to fix multiple security vulnerabilities in the widely installed program.

POC: Alfredo A. Ortiz, alfredo.a.ortiz@nasa.gov, (650) 604-0294, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Systems Experts Resolve Complex Memory Leak Issue Impacting User Jobs

- The HECC Supercomputing Systems team, in collaboration with SGI and Intel support staff resolved a memory leak issue on Pleiades and Endeavour that was impacting user jobs.
- The issue took three months to diagnose and resolve due to difficultly in consistently reproducing the problem. Several user codes exhibited the issue, but not regularly enough for SGI (the system vendor) to identify the root cause.
- After an extensive effort, HECC and SGI engineers developed a consistent reproducer after narrowing the issue to the Lustre filesystem software.
- Intel staff were then able to quickly pinpoint the memory leak issue and provided a patch. HECC engineers deployed the patch on all resources, and the fix will be incorporated in the next Lustre software release.

Mission Impact: Maintaining strong collaborative partnerships with vendors allows HECC systems engineers to more quickly resolve complex technical issues that impact users running applications for NASA mission projects.

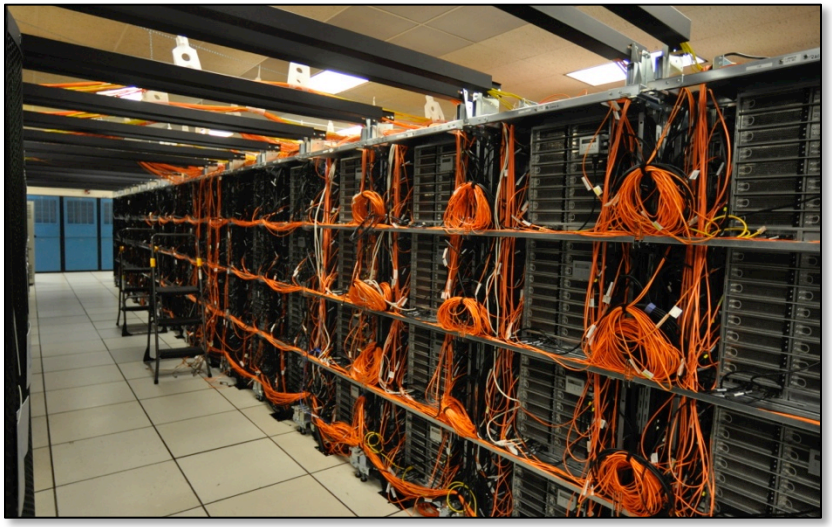
The Endeavour supercomputer, above, exhibited a memory leak issue more frequently than Pleiades due to its shared-memory architecture. This platform was the first system that system engineers could consistently reproduce the problem on, which allowed them to narrow the issue down to software in the Lustre filesystem.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Sciences Corp.

HECC Resolves InfiniBand Issue Affecting Pleiades Performance for Some Users

- The HECC Supercomputing Systems team working with SGI and Mellanox staff resolved an issue on Pleiades' InfiniBand fabric that was impacting large-scale user jobs.
- Several changes were made to address the scaling issue on the system, including:
  - Replaced several hundred cables to address physical link layer issues.
  - Installed new firmware for InfiniBand switches and cards.
  - Updated the Ivy Bridge BIOS (Basic Input/ Output System) to improve InfiniBand packet performance between nodes.
  - Enhanced the SGI Message Passing Interface library software to improve congestion controls on the InfiniBand fabric.
- These changes enabled a half-scale (35,000 rank) and full-scale (70,000 rank) MITgcm application to run successfully on Pleiades without any packet loss.

Mission Impact: A stable, high-performance InfiniBand network is crucial for scientists and engineers to be able to productively use the Pleiades supercomputer for NASA missions.



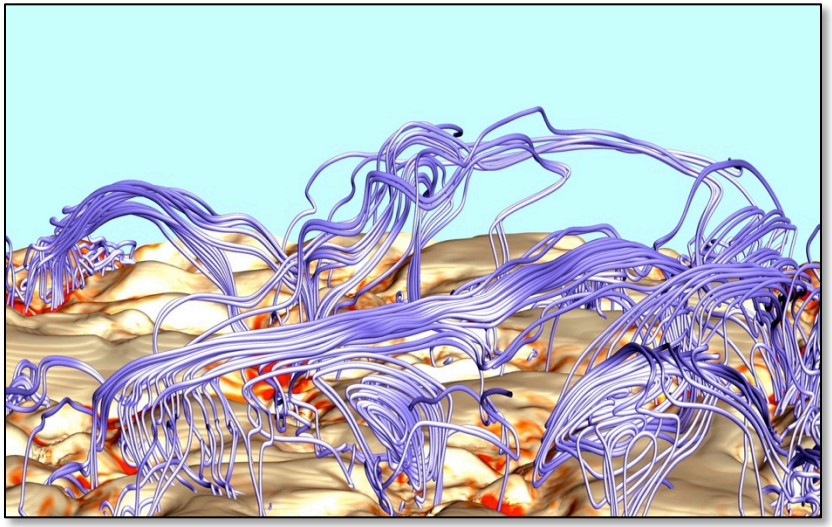
The Pleiades supercomputer contains over 65 miles of InfiniBand cabling that interconnects the compute nodes and HECC storage subsystems.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Science Corp.

Simulations Run on Pleiades Help Reveal the Origins of the Sun's 'Magnetic Carpet' *

- Researchers at NASA Ames Research Center are running simulations on Pleiades to investigate solar variability, a leading factor in determining space weather.
- The research provides insight into the process known as the "solar dynamo," which generates the magnetic fields that carpet the Sun. Simulations of the Sun's surface, interior, and atmosphere have revealed:
  - The small-scale dynamo process is turbulent, and results in the amplification of magnetic fields from an extremely weak initial strength of 10^{-2} – 10^{-6} Gauss to stronger than 1,000 Gauss.
  - The local dynamo process has the strongest efficiency in subsurface layers of the Sun's convective zone, just beneath the visible surface.
- These findings help explain the dramatic changes that occur near the solar surface, providing a better understanding of the mechanisms that lead to sunspots, active regions, and the solar storms that form there.
- Results are also being used to help calibrate and interpret data from NASA's Solar Dynamics Observatory, Hinode, and Interface Region Imaging Spectrograph (IRIS).

Mission Impact: Simulations of solar activity, enabled by HECC resources, help NASA researchers gain a better understanding of the Sun's structure and dynamics, which is crucial for improving space weather prediction capabilities.



Visualization of the Sun's "magnetic carpet," simulated using the parallel 3D radiative magnetohydrodynamics code SolarBox on the Pleiades supercomputer. The "carpet" consists of small-scale magnetic fields generated by turbulent dynamo action just beneath the solar surface. *Irina Kitiashvili, Tim Sandstrom, NASA/Ames*

POCs: Irina Kitiashvili, irina.n.kitiashvili@nasa.gov, (650) 723-9596, NASA Ames Research Center, Oak Ridge Associated Universities, Alan Wray, alan.a.wray@nasa.gov, (650) 604-6066, NASA Ames Research Center

** HECC provided supercomputing resources and services in support of this work*

Pleiades Enables Accurate Simulation of Fluid-Structure Phenomena in Propulsion Systems *

- Engineers at Marshall Space Flight Center (MSFC) have run complex simulations on Pleiades to investigate fluid-structure interactions on the Space Launch System (SLS) solid rocket motors (SRMs), as part of the vehicle design process.
- Using a recently developed, multidisciplinary simulation tool, the MSFC team accurately solved and verified the accuracy of the complex, fully coupled fluid-structure numerical simulations.
- Initial coupled results indicated that, due to acoustic coupling, the dynamics of one of the more flexible inhibitors shift from free vibration to forced vibration at the first acoustic frequency of the solid rocket motor.
- The team will also study other fluid-structural phenomena in the SLS, such as liquid propellant tank breathing due to propellant interaction with the flexible tank shell, interactions between launch pad water suppression system and ignition overpressure waves on lift-off, and fluid-thermal-structural coupling of rocket engine nozzles.
- The highly compute- and memory-intensive SLS SRM simulations performed on Pleiades used 1,000 processors and 1–3 weeks run-time per case.

Mission Impact: Enabled by HECC's Pleiades supercomputer, engineers verified the accuracy of a new simulation tool used to analyze thrust oscillations and structural vibration modes in launch vehicles. The ability to accurately predict oscillation features is crucial for development of the Space Launch System.

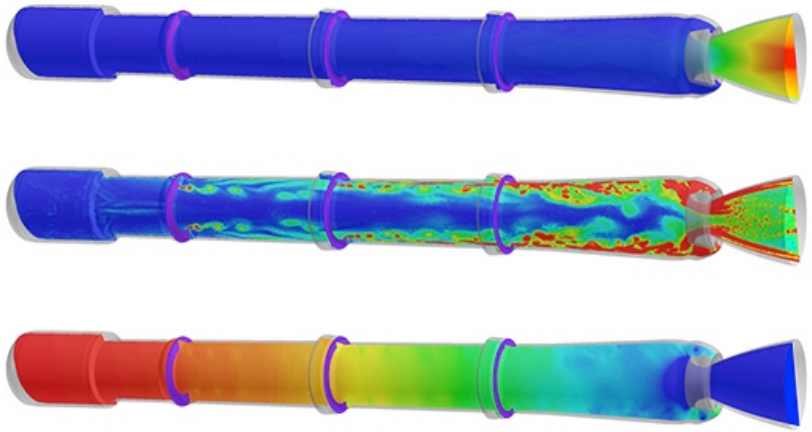


Image from a coupled fluid-structure interaction simulation of the Space Launch System (SLS) solid rocket motor with flexible inhibitors, showing the instantaneous Mach number field (top), the instantaneous vorticity field (middle), and the instantaneous pressure field (bottom).

POCs: H. Q. Yang, hong.q.yang@nasa.gov, (256) 544-8978, Jeff West, jeffrey.s.west@nasa.gov, (256) 544-6309, NASA Marshall Space Flight Center

** HECC provided supercomputing resources and services in support of this work*

HECC Facility Hosts Several Visitors and Tours in June 2014

- HECC hosted 3 tour groups in June; guests learned about the agency-wide missions being supported by Pleiades, and viewed the D-Wave Two system.
- NOTE: The hyperwall computer system is being upgraded this month, many tours have been postponed until the upgrade is completed.
- Visitors this month included:
  - Josh Bernstein, an American explorer, author, survival expert, anthropologist, and TV host of several segments on the History and Discovery channels, received a tour of the NAS facility for possible collaboration on a new project called "Explorer at Large."
  - Robert "Bob" H. Lee and other guests of Pete Worden (from Square, Immersive Environments, World Champ Tech, and Google Ventures) received an overview of HECC and the quantum computing system.
  - A contingent of staff and students from the Khan Academy received an overview of the supercomputers and quantum computing system at the facility.

NASA Advanced Supercomputing (NAS) Division Chief, Piyush Mehrotra (back row, right), gave a tour of the NAS facility's main computer room, and explained the basics of quantum computing to staff and students from the Khan Academy.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division

Phi-based Systems

- **Background:**
  Two Intel Xeon Phi-based systems are being utilized as pathfinding resources to determine whether the Many Integrated Core (MIC) Architecture is cost effective for NASA's computational requirements.
  - Maia is a 128-node SGI system with two Xeon Phi accelerator cards in each node.
  - Mira is a 64-node Cray system with two Xeon Phi accelerator cards in each node.
- **Status**
  - Maia is now running the latest system software, with security patches applied. Minor issues arising from the upgrade were corrected, and the system is available for testing. There was no user activity.
  - Mira is being "NASified." NAS engineers are working with Cray to re-install system software to comply with NASA security requirements; this is a time-consuming process.
- **Upcoming Activities for June**
  - Maia: The system will be available for testing.
  - Mira: The "NASification" process will most likely continue for a few more weeks.

Papers and Presentations

- "**Gas Loss in Simulated Galaxies as They Fall into Clusters**," R. Cen, A. Pop, N. Bahcall, Proceedings of the National Academy of Sciences, vol. 111, no. 22, June 3, 2014.* *http://www.pnas.org/content/111/22/7914.full?sid=a4d592c1-e7b4-4f58-af37-0f588c87cebd*
- "**Gravito-Turbulent Disks in Three Dimensions: Turbulent Velocities Versus Depth**," J.-M. Shi, E. Chiang, The Astrophysical Journal, vol. 789, no. 1, June 11, 2014. * *http://iopscience.iop.org/0004-637X/789/1/34*
- "**Analysis of the Common Research Model Using Structured and Unstructured Meshes**," A. Sclafani, et al, Journal of Aircraft (Ahead of Print), June 13, 2014. * *http://arc.aiaa.org/doi/pdf/10.2514/1.C032411*
- "**Bayesian Inversion for Finite Fault Earthquake Source Models – II: the 2011 Great Tohoku-oki Japan Earthquake**," S. Minson, et al, Geophysical Journal International, vol. 198, issue 2, June 15, 2014. * *http://gji.oxfordjournals.org/content/198/2/922.short*
- "**Kinematic Evolution of Simulated Star-Forming Galaxies**," S. Kassin, A. Brooks, F. Governato, B. Weiner, J. Gardner, arXiv:1406.5187 [astro-ph.GA], June 19, 2014. * *http://arxiv.org/abs/1406.5187*
- "**Frequency Domain Flutter Boundary Computations Using Navier-Stokes Equations on Superclusters**," G. Guruswamy, Journal of Aircraft (Ahead of Print), June 20, 2014. * *http://arc.aiaa.org/doi/pdf/10.2514/1.C032126*

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Papers and Presentations (cont.)

- "**Magnetic Deflections of Ultra-High Energy Cosmic Rays from Centaurus A**," A. Keivani, G. Farrar, M. Sutherland, arXiv:1406.5249 [astro-ph.HE], June 20, 2014. * *http://arxiv.org/abs/1406.5249*
- "**The Kinetic Ballooning/Interchange Instability as a Source of Dipolarization Fronts and Auroral Streamers**," P. L. Pritchett, F. V. Coroniti, Y. Nishimura, Journal of Geophysical Research: Space Physics (Early Access), June 27, 2014. * *http://onlinelibrary.wiley.com/doi/10.1002/2014JA019890/abstract*
- **3rd AIAA Workshop on Benchmark Problems for Airframe Noise Computations (BANC-III)**, Atlanta, GA, June 14-15, 2014.
  - "**Slat Noise Simulation Results Using LAVA**," Jeff Housman. *
  - "**LAVA Simulations for the AIAA BANC-III Workshop - Landing Gear**," Christoph Brehm. *
- **AIAA Aviation Forum 2014,** Atlanta, GA, June 16-20, 2014.
  - "**Toward Ablative Material Response Coupling in DPLR**," N. Mansour, et al. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2120*
  - "**LAVA Simulations for the First AIAA Sonic Boom Prediction Workshop**," J. Housman, E. Sozer, C. Kiris. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2008*
  - "**A High-Order Immersed Interface Method for Compressible Flows**," C. Brehm, et al. * *http://arc.aiaa.org/doi/pdfplus/10.2514/6.2014-2093*
  - "**High Lift OVERFLOW Analysis of the DLR F11 Wind Tunnel Model**," T. Pulliam, A. Sclafani. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2697*

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Papers and Presentations (cont.)

- **AIAA Aviation Forum 2014** (cont.)
  - "**Velocity/Pressure-Gradient Correlations in a FORANS Approach to Turbulence Modeling**," S. Murman, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2207
  - "**Optimization of Perturbation Parameters for Simulated Free Shear Layer Flow**," U. Kaul, et al.*
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2223
  - "**Experimental and Computational Sonic Boom Assessment of Boeing N+2 Low Boom Models**," S. Cliff, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2140
  - "**Visualization of Flow Separation Around an Atmospheric Re-Entry Capsule at Low-Subsonic Mach Number Using Background-Oriented Schlieren (BOS)**," S. Murman, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2521
  - "**Drag Optimization Study of Variable Camber Continuous Trailing Edge Flap (VCCTEF) Using OVERFLOW**," U. Kaul, et al. *
    http://arc.aiaa.org/doi/pdfplus/10.2514/6.2014-2444
  - "**DNS of Flows over Periodic Hills Using a Discontinuous Galerkin Spectral-Element Method**," S. Murman, L. Diosady. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2784
  - "**Time-Spectral Rotorcraft Simulations on Overset Grids**," J. Leffell, S. Murman, T. Pulliam. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-3258
  - "**Numerical Study of a Long-Lived, Isolated Wake Vortex in Ground Effect**," F. Proctor. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2469

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Papers and Presentations (cont.)

- **AIAA Aviation Forum 2014** (cont.)
  - "**Generalized Multi-Group Macroscopic Modeling for Thermo-Chemical Non-Equilibrium Gas Mixtures**," Y. Liu, M. Vinokur, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-3205
  - "**Towards Full Aircraft Airframe Noise Prediction: Detached Eddy Simulations**," M. Khorrami, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2480
  - "**Towards Full Aircraft Airframe Noise Prediction: Lattice Botlzmann Simulations**," M. Khorrami, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2481
  - "**First Principles Based PID Control of Mixing Layer: Role of Inflow Perturbation Spectrum**," U. Kaul. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2222
  - "**Simulation of Fluid Flow and Collection Efficiency for a SEA Multi-Element Probe**," D. Rigby, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2752
  - "**Analysis of Numerical Simulation Database for Pressure Fluctuations Induced by High-Speed Turbulent Boundary Layers**," L. Duan, M. Choudhari. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2912
  - "**Large-Eddy/Reynolds-Averaged Navier-Stokes Simulation of Cavity-Stabilized Ethylene Combustion**," A. Potturi, J. Edwards. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2095

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Papers and Presentations (cont.)

- **AIAA Aviation Forum 2014** (cont.)
  - "**Assessment of Higher-Order RANS Closures in a Decelerated Planar Wall-Bounded Turbulent Flow**," E. Jeyapaul, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2088
  - "**Grid-Adapted FUN3D Computations for the Second High Lift Prediction Workshop (Invited)**," E. Lee-Rausch, et al. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2395
  - "**An Examination of Parameters Affecting Large Eddy Simulations of Flow Past a Square Cylinder**," M. Mankabadi, N. Georgiadis. *
    http://arc.aiaa.org/doi/pdf/10.2514/6.2014-2089
- **International Supercomputing Conference (ISC-14),** Leipzig, Germany, June 22-25, 2014.
  - "**Future of High Performance Computing: A NASA Perspective**," Rupak Biswas.
  - "**NASA Embarks on the Quantum Computing Path**," Rupak Biswas.
  - Biswas also chaired the ISC Vendor Showdown and Quantum Computing sessions.

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Papers and Presentations (cont.)

- **Probabilistic Safety Assessment and Management Conference (PSAM12),** Honolulu, HI, June 22-27, 2014.
  - "**Cabin Environment Physics Risk Model**," C. Mattenberger, D. Mathais. *
  - "**Physics-based Entry, Descent and Landing Risk Model**," K. Gee, L. Huynh, T. Manning. *
  - "**Physics-based Fragment Acceleration Modeling for Pressurized Tank Burst Risk Assessments**," T. Manning, D. Mathias, K. Gee. *
  - "**A Failure Propagation Modeling Method for Launch Vehicle Safety Assessment**," S. Lawrence, D. Mathias, K. Gee. *
  - "**An Integrated Reliability and Physics-based Risk Modeling Approach for Assessing Human Spaceflight Systems**," S. Go, et al. *
  - "**Engineering Risk Assessment of Space Thruster Challenge Problem**," D. Mathias, et al. *

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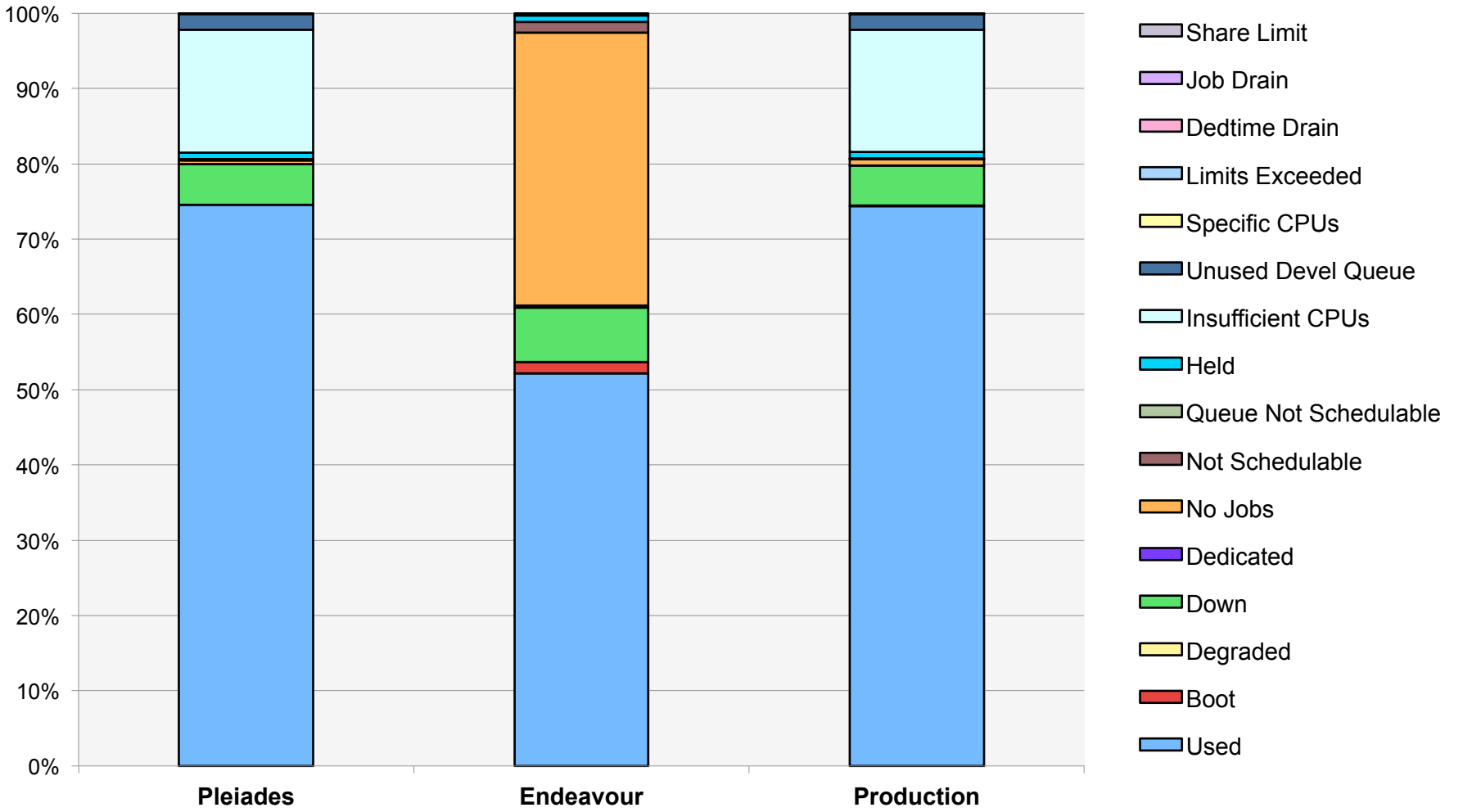
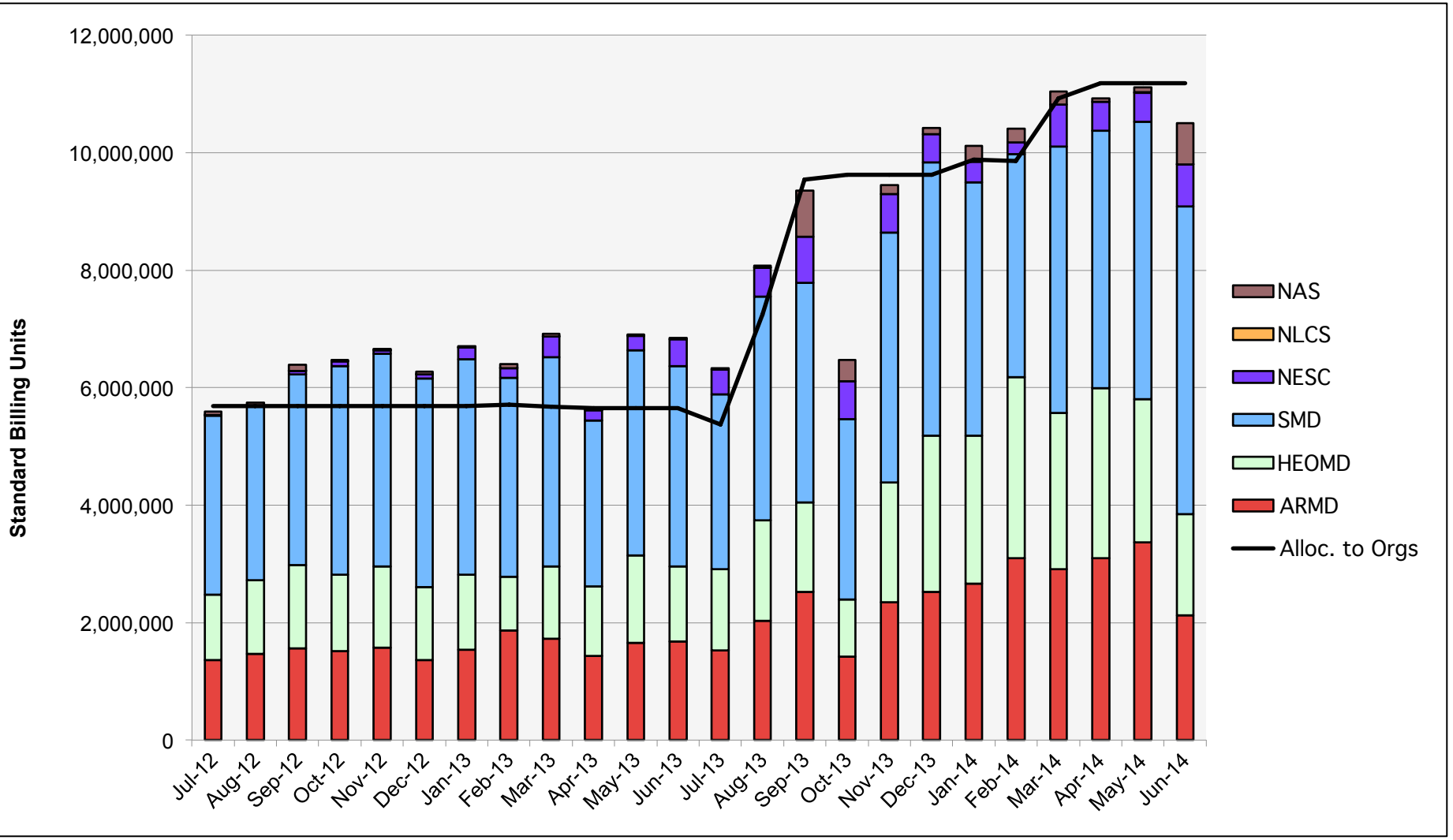
News and Events

- **Case Study: NAS Tape-based Solution to Manage and Store High-Volume Data**, *Active Archive*, June 2, 2014—The Active Archive Alliance performed a small study on the mass storage and archiving systems at the NAS facility. They looked specifically at the automated method of archiving data from disk to tape, which saves energy and space while still making data easily accessible to users. *http://www.activearchive.com/common/pdf/AACaseStudyNASAAmes.pdf*
- **NASA Launches Earth Science Challenges with OpenNEX Cloud Data**, *NASA,* June 24, 2014—NASA is launching a two-stage challenge to give the public an opportunity to create innovative ways to use Earth science data from the Open NASA Earth Exchange (OpenNEX) supercomputing and knowledge platform. *http://www.nasa.gov/press/2014/june/nasa-launches-earth-science-challenges-with-opennex-cloud-data*

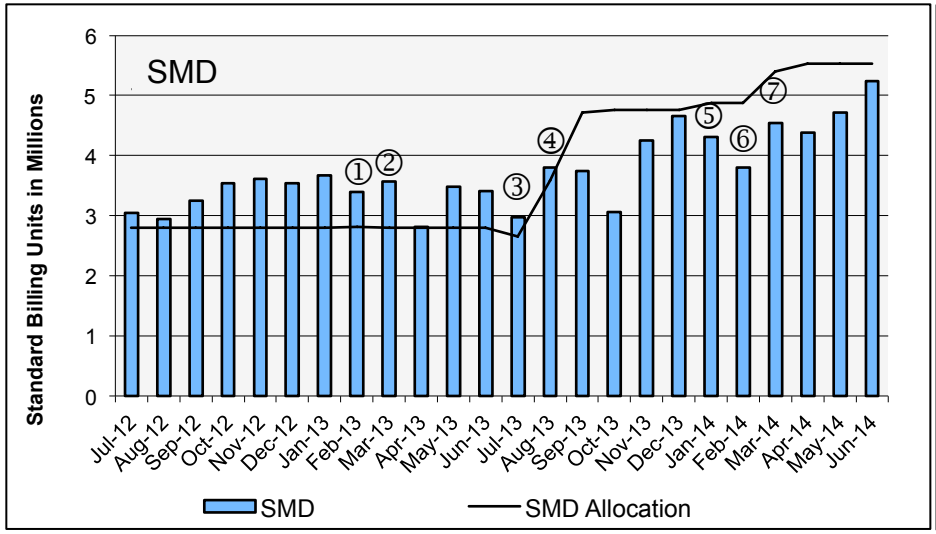
HECC Utilization

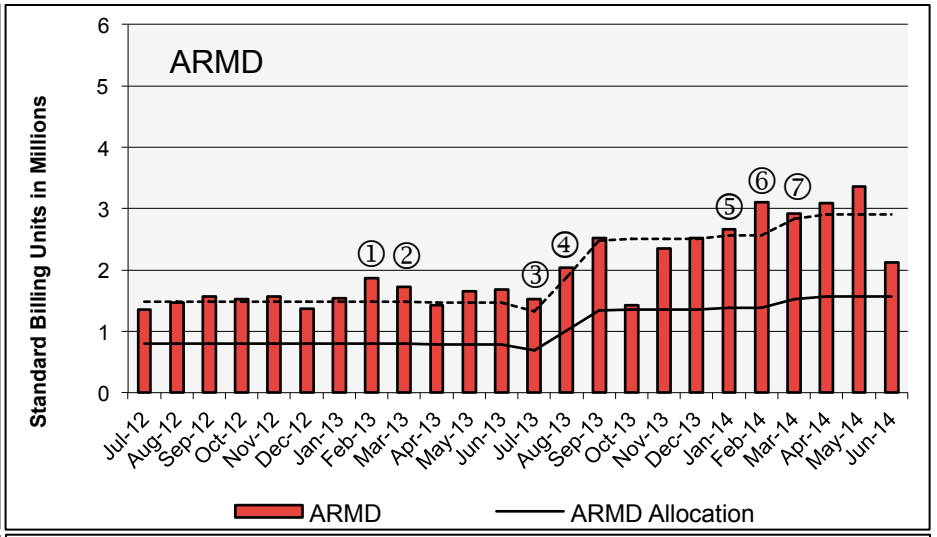


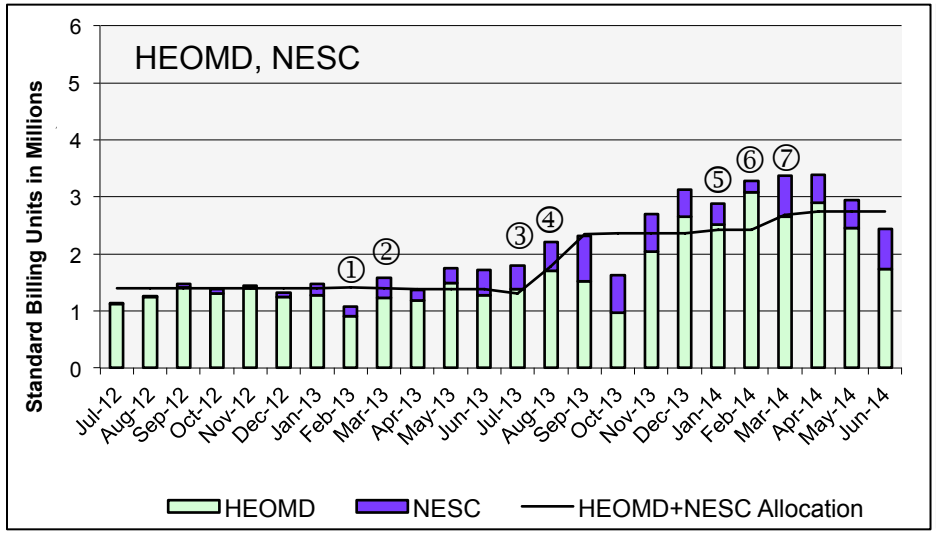
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







① Columbia 21, 23, and 24 retired, Endeavour 2 added

② Columbia 22 retired; Endeavour 1 added

③ 32 Harpertown Racks retired

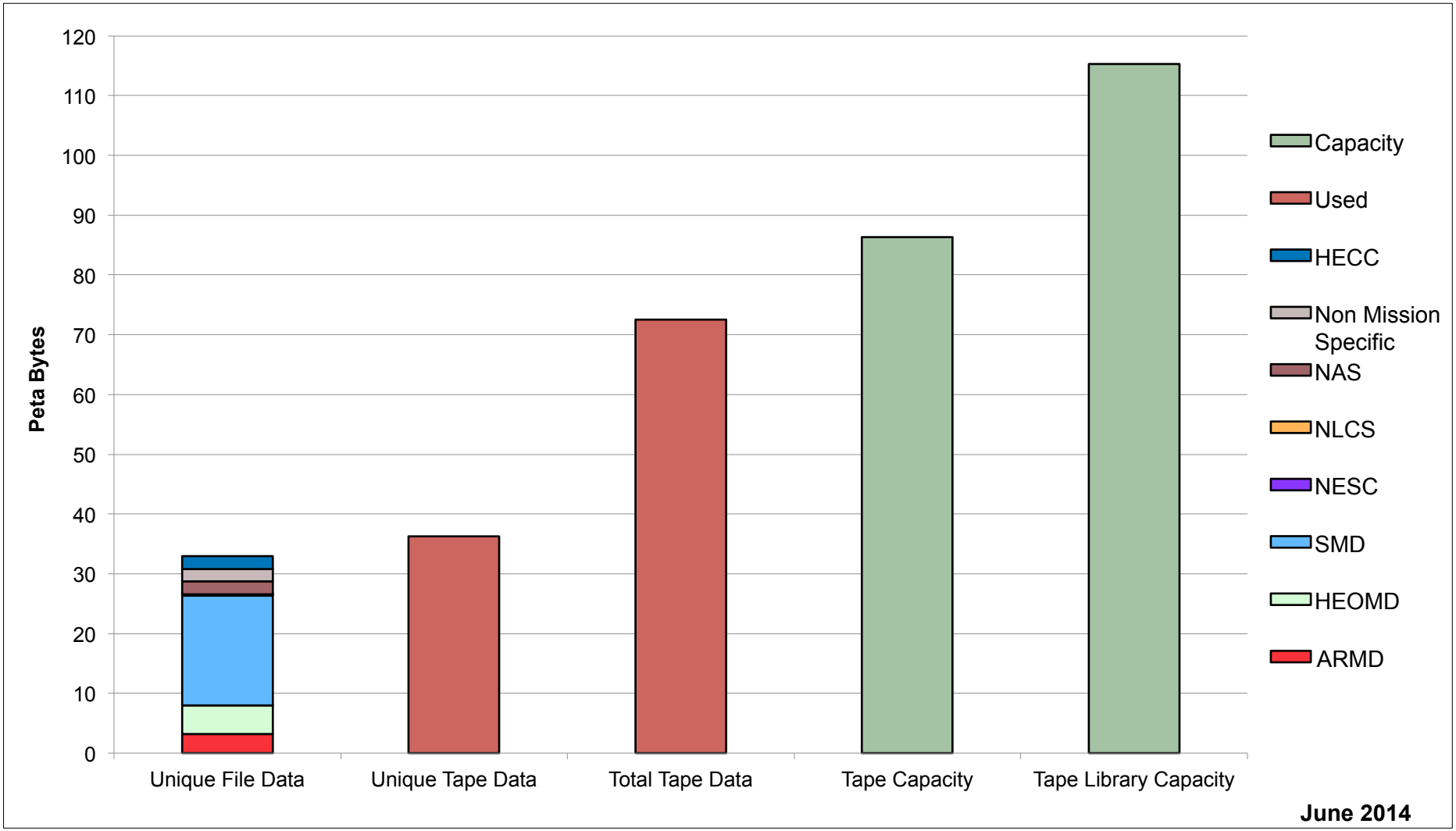
④ 32 Harpertown Racks retired; 46 Ivy Bridge Racks added

⑤ 6 Ivy Bridge Racks added; 20 Nehalem and 12 Westmere Racks Retired

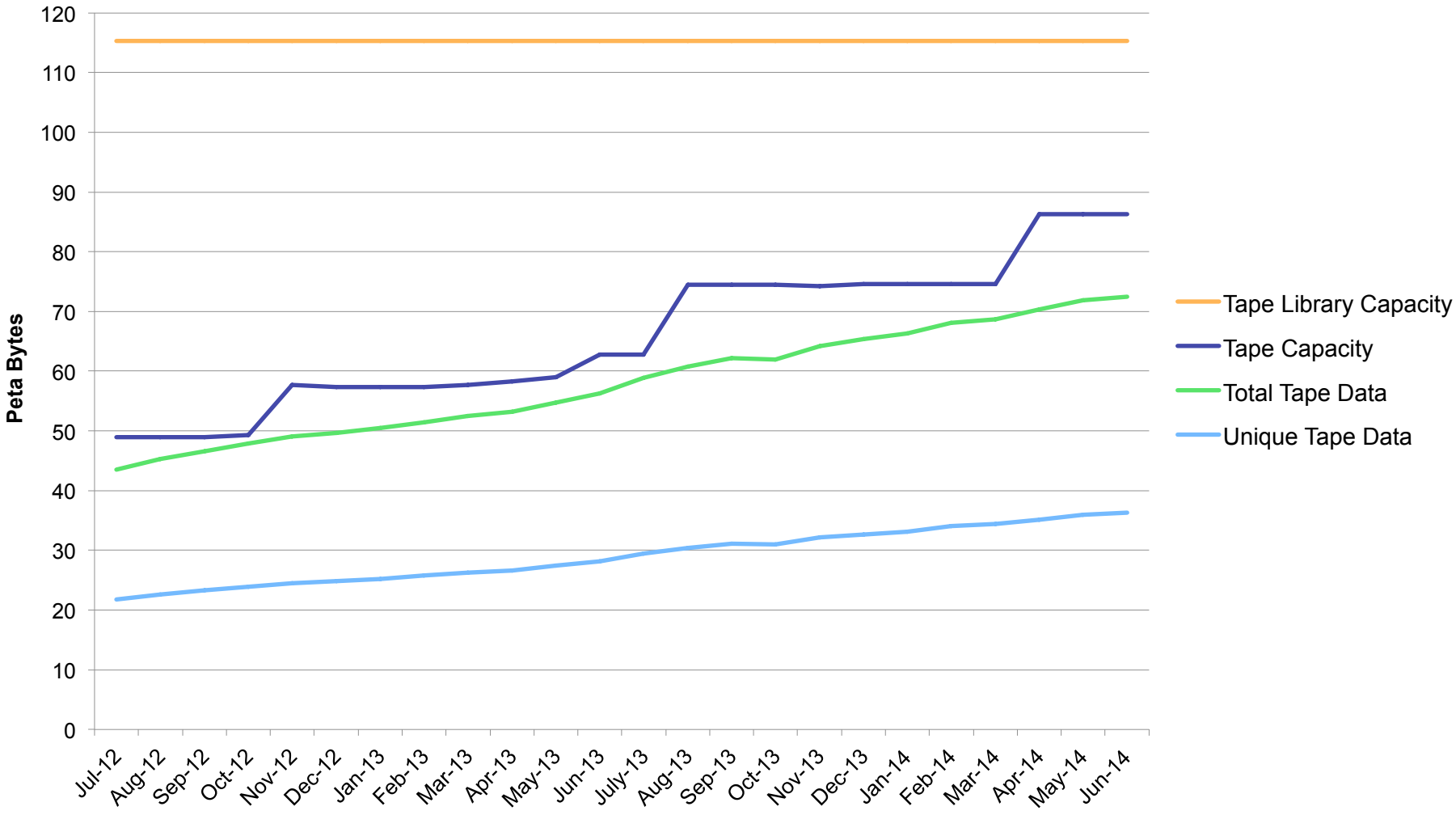
⑥ 8 Ivy Bridge Racks added mid-Feb; 8 additional Ivy Bridge Racks late Feb.

⑦ 4 Ivy Bridge Racks added mid-March

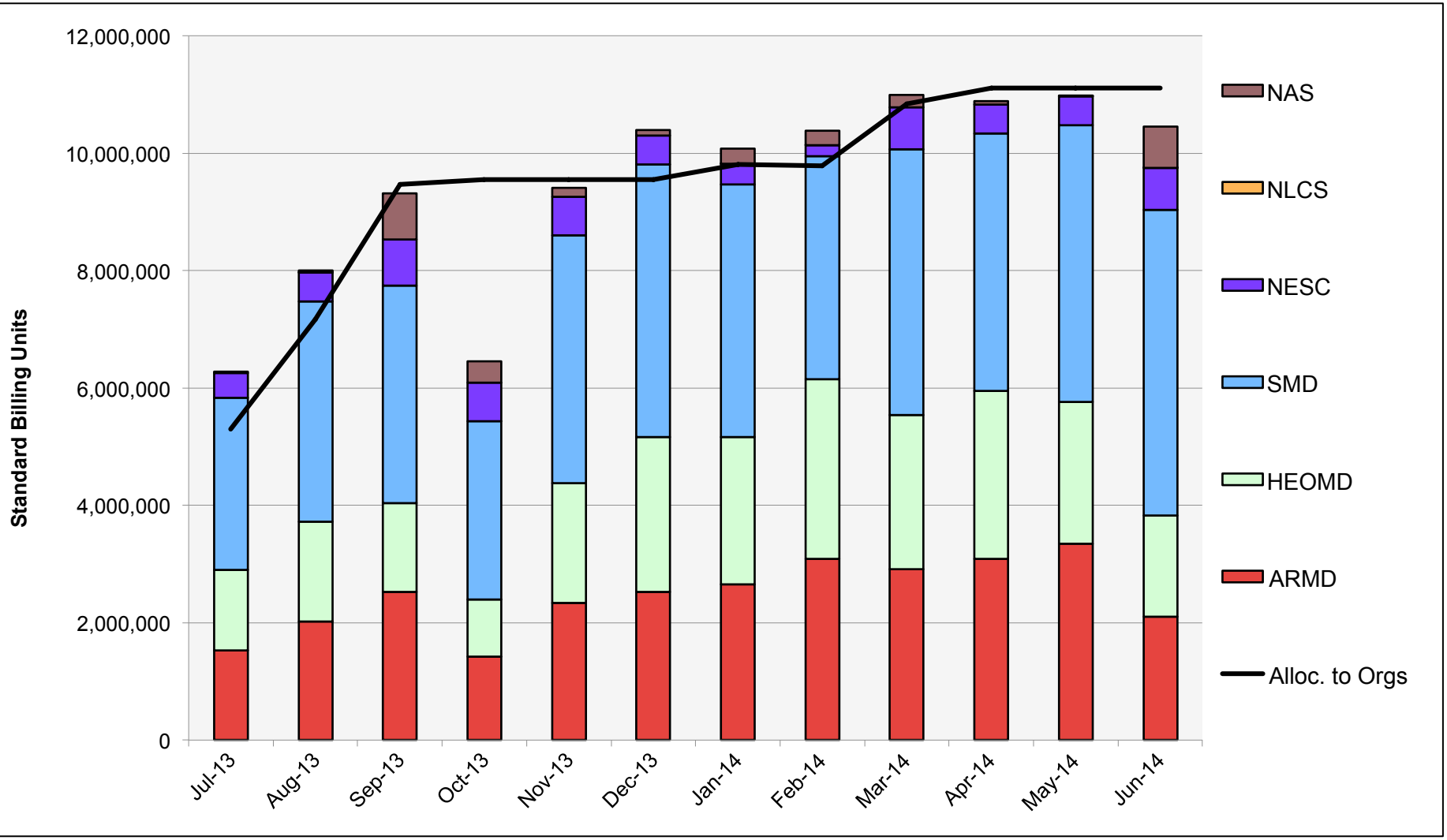
Tape Archive Status



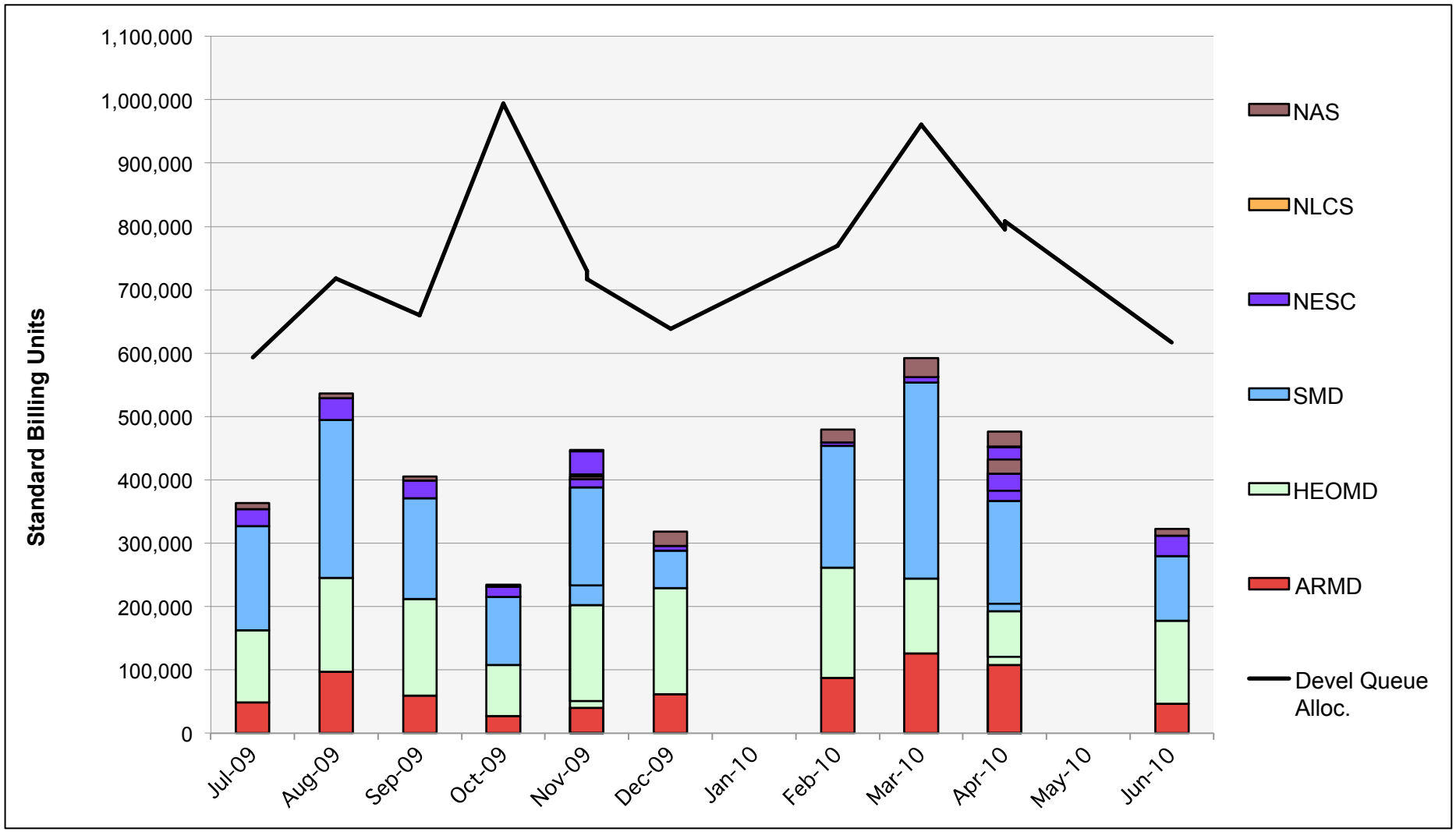
Tape Archive Status



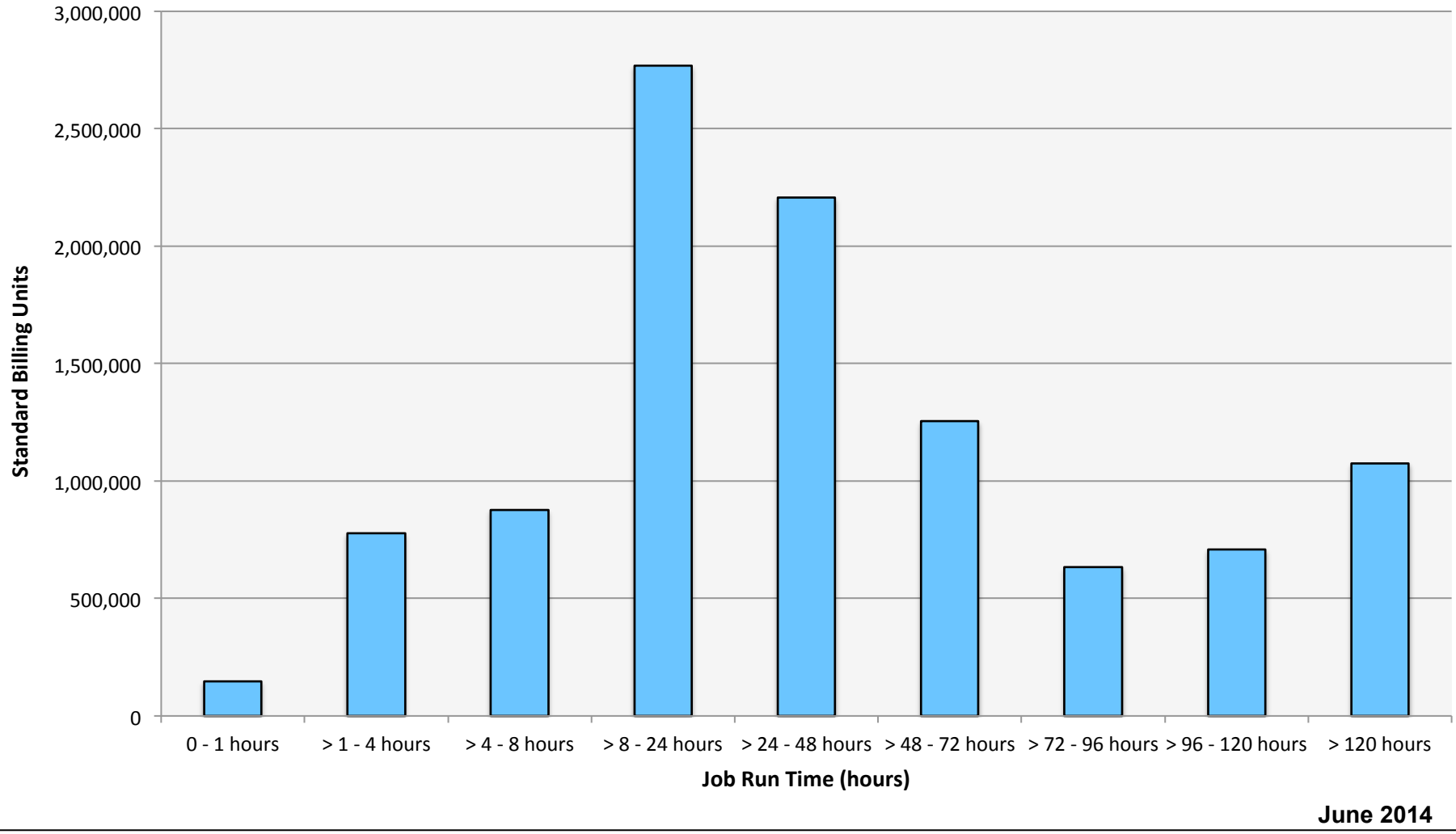
Pleiades:
SBUs Reported, Normalized to 30-Day Month



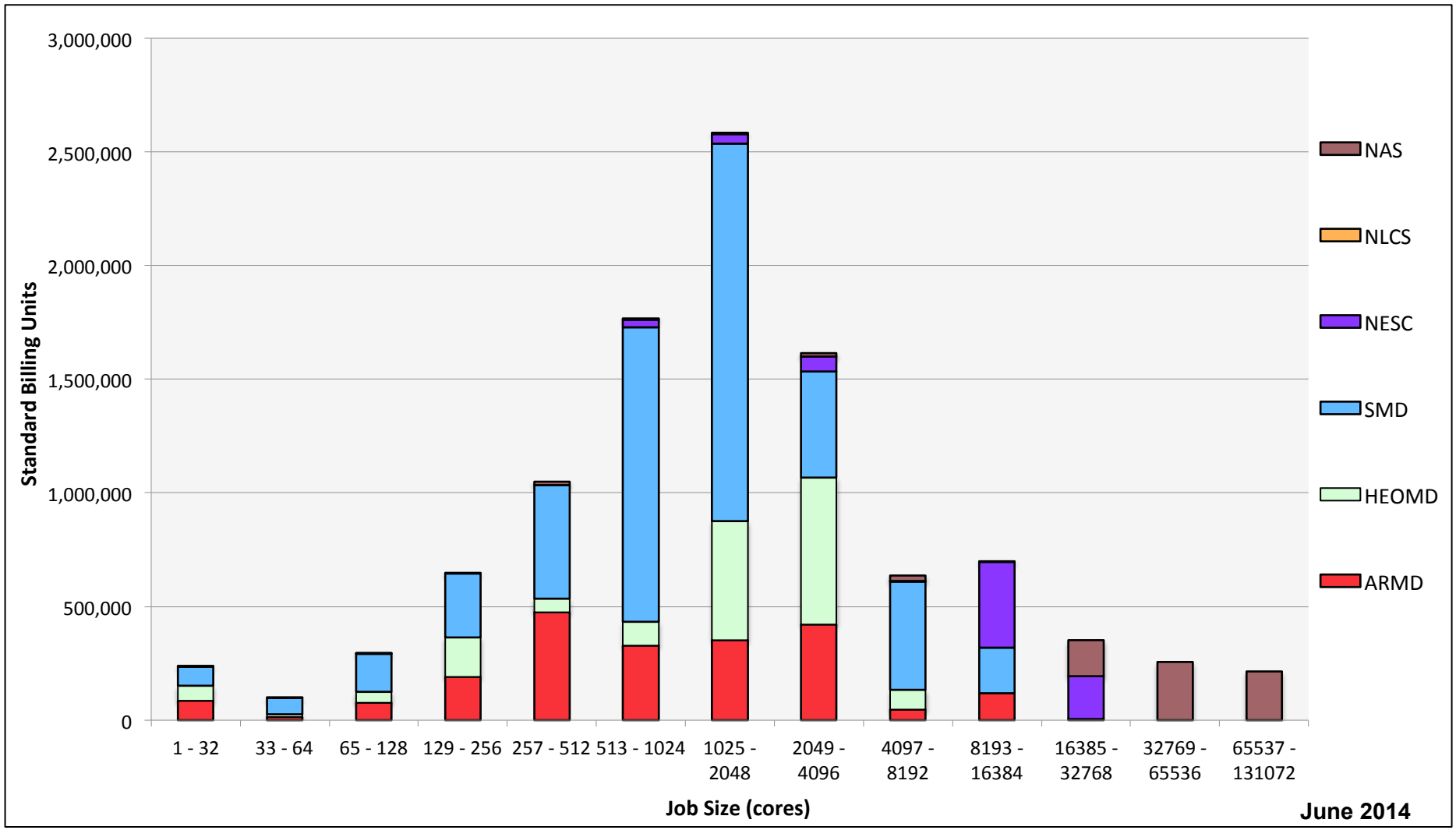
Pleiades:
Devel Queue Utilization



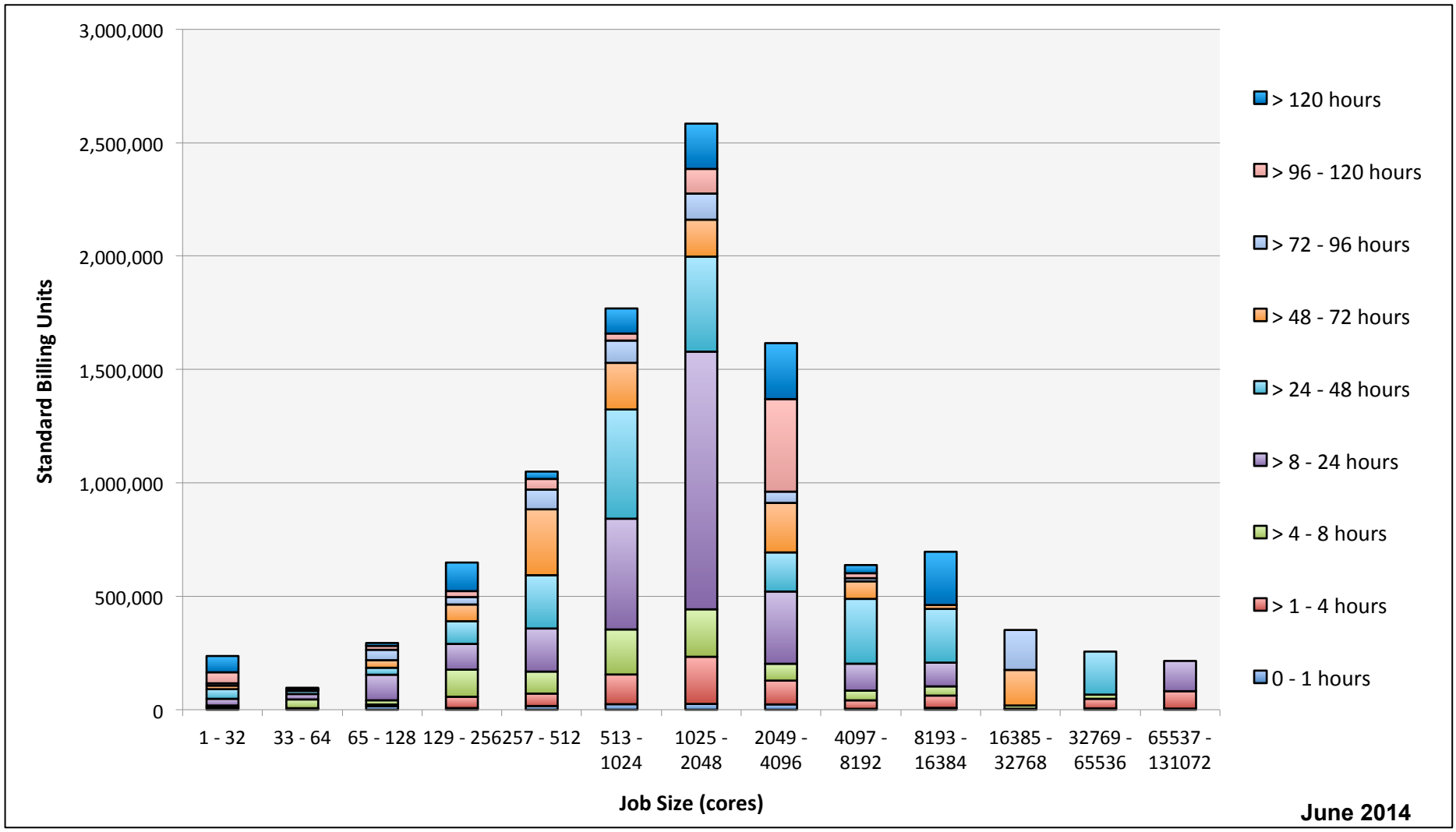
Pleiades:
Monthly Utilization by Job Length



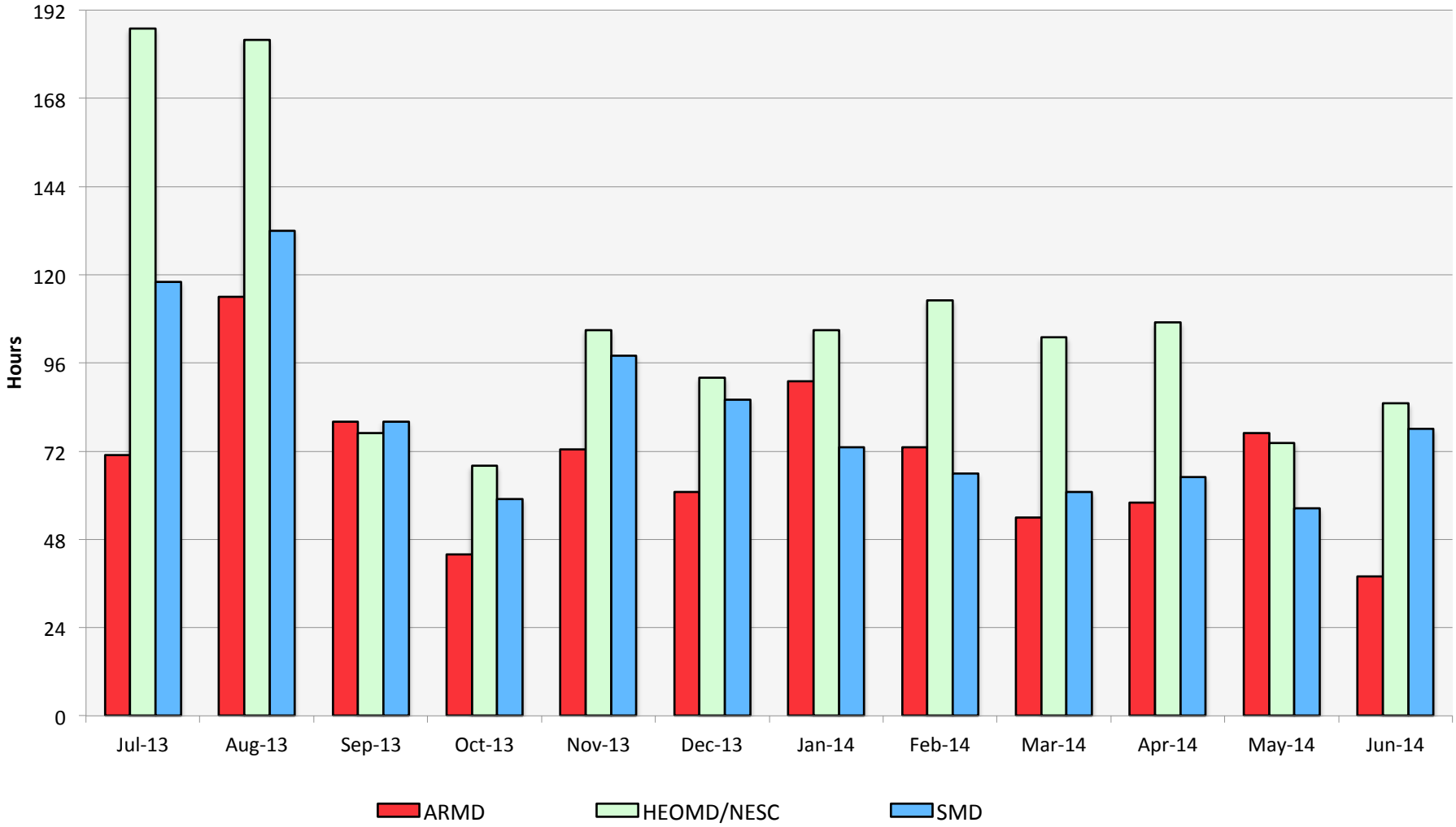
Pleiades:
Monthly Utilization by Size and Mission



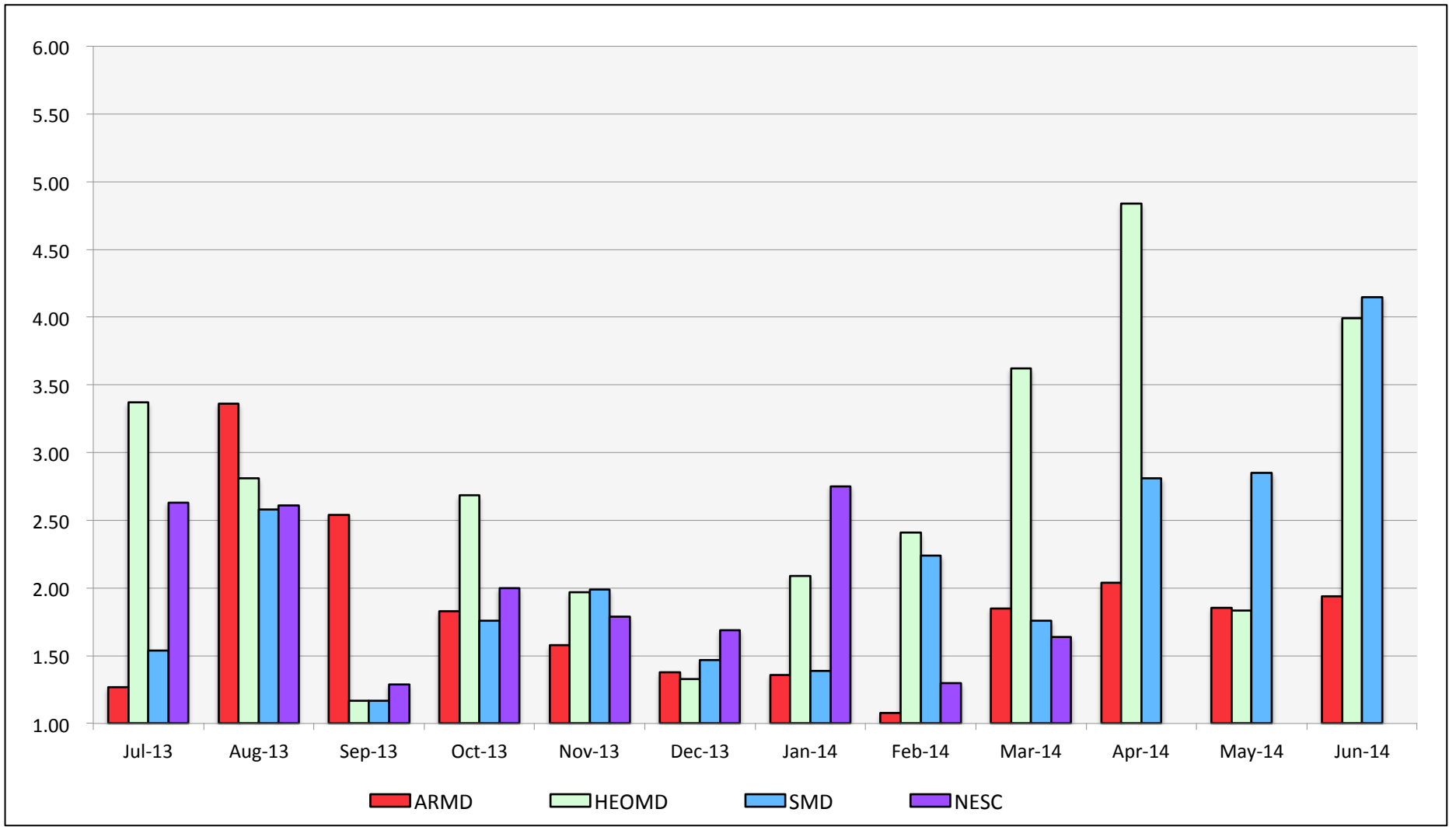
Pleiades:
Monthly Utilization by Size and Length



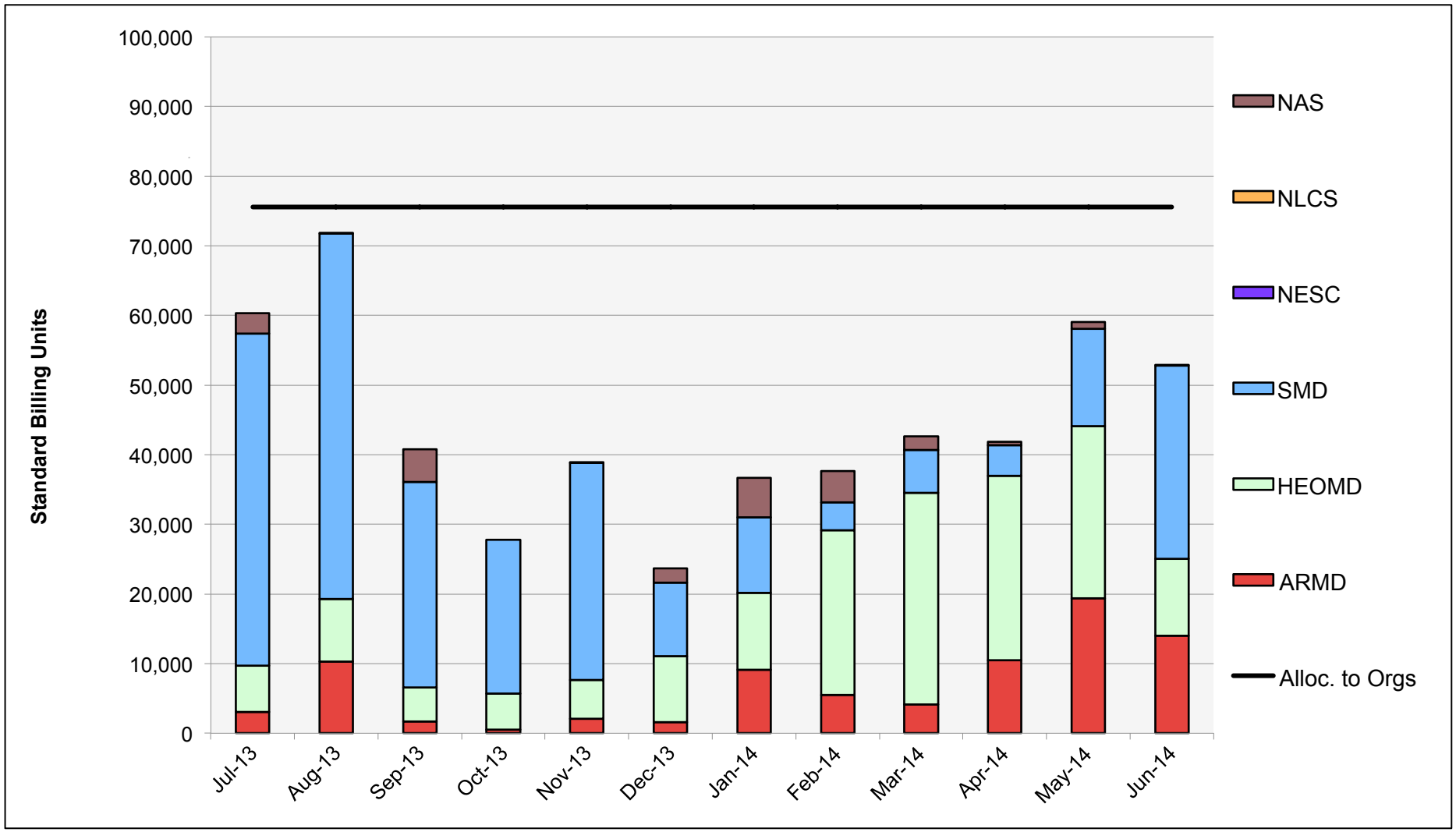
Pleiades:
Average Time to Clear All Jobs



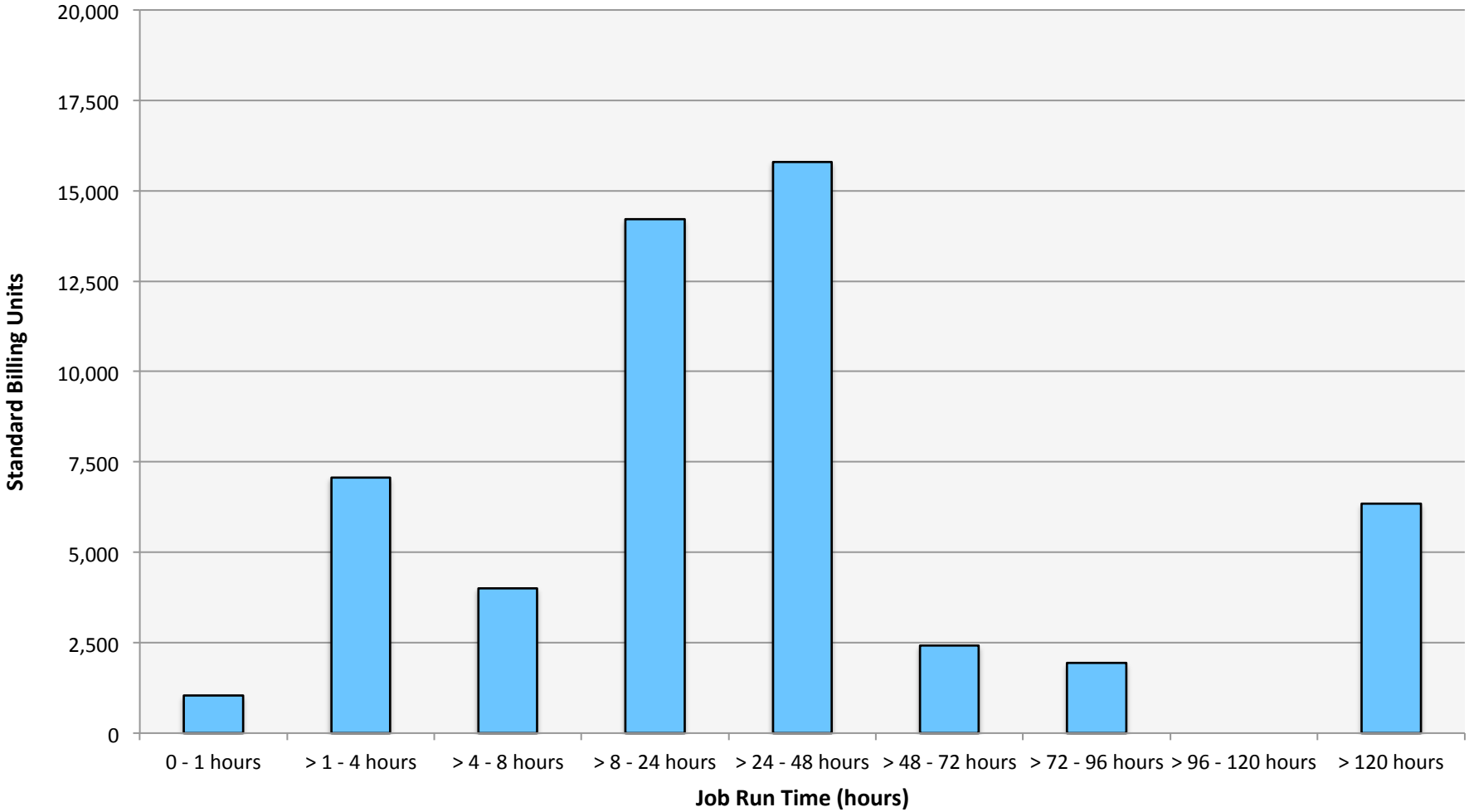
Pleiades:
Average Expansion Factor



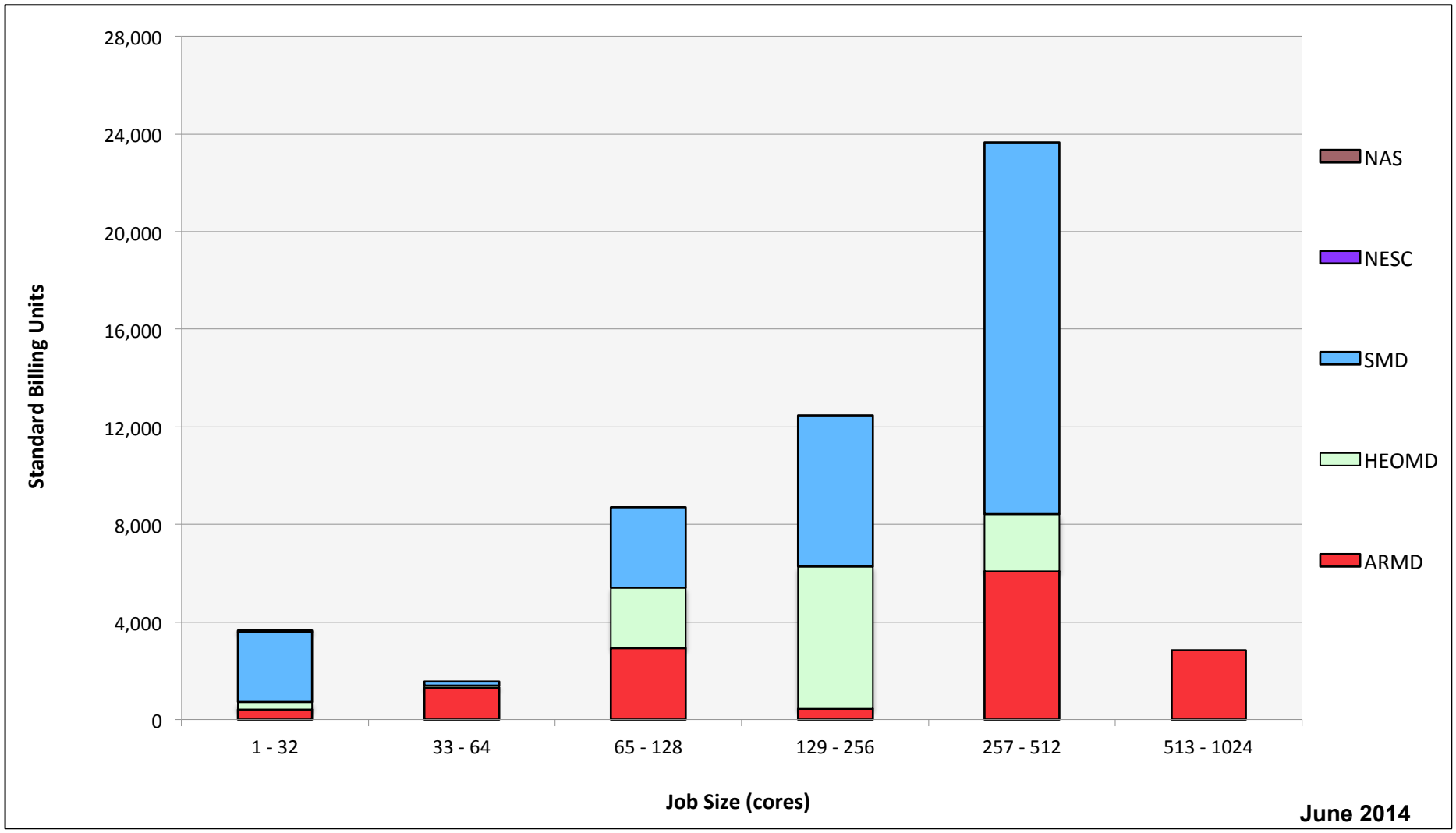
Endeavour:
SBUs Reported, Normalized to 30-Day Month



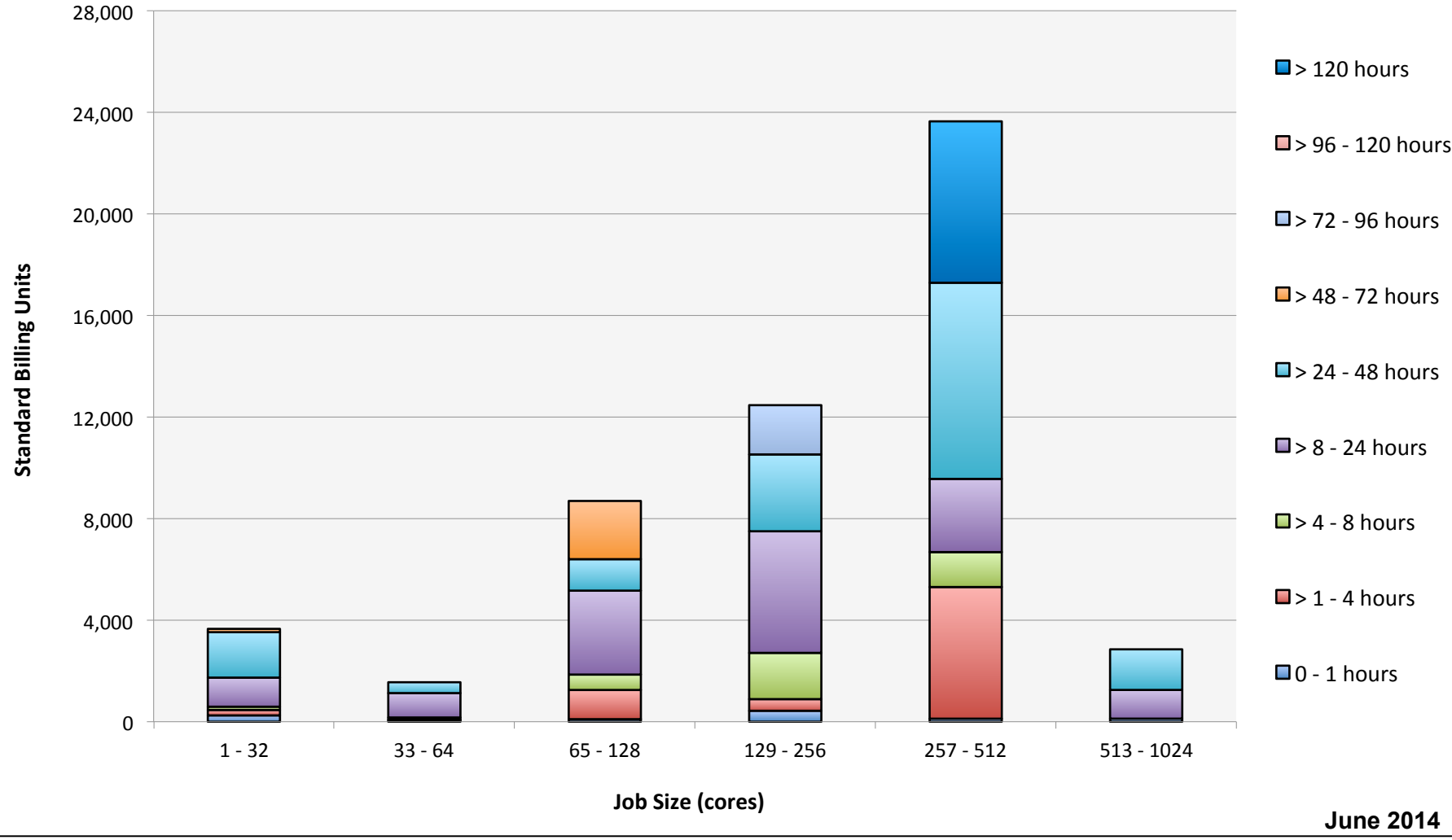
Endeavour:
Monthly Utilization by Job Length



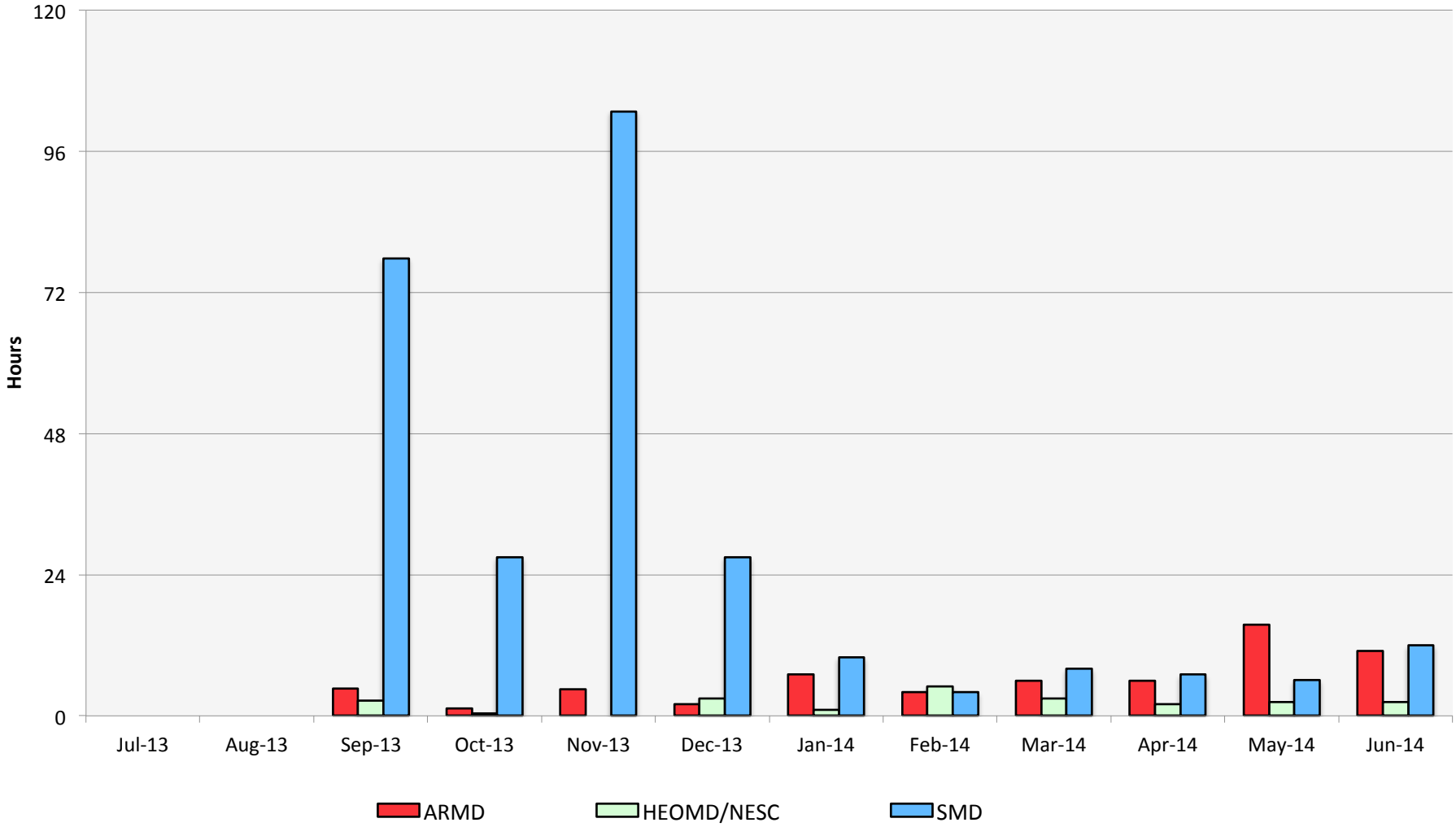
Endeavour:
Monthly Utilization by Size and Mission



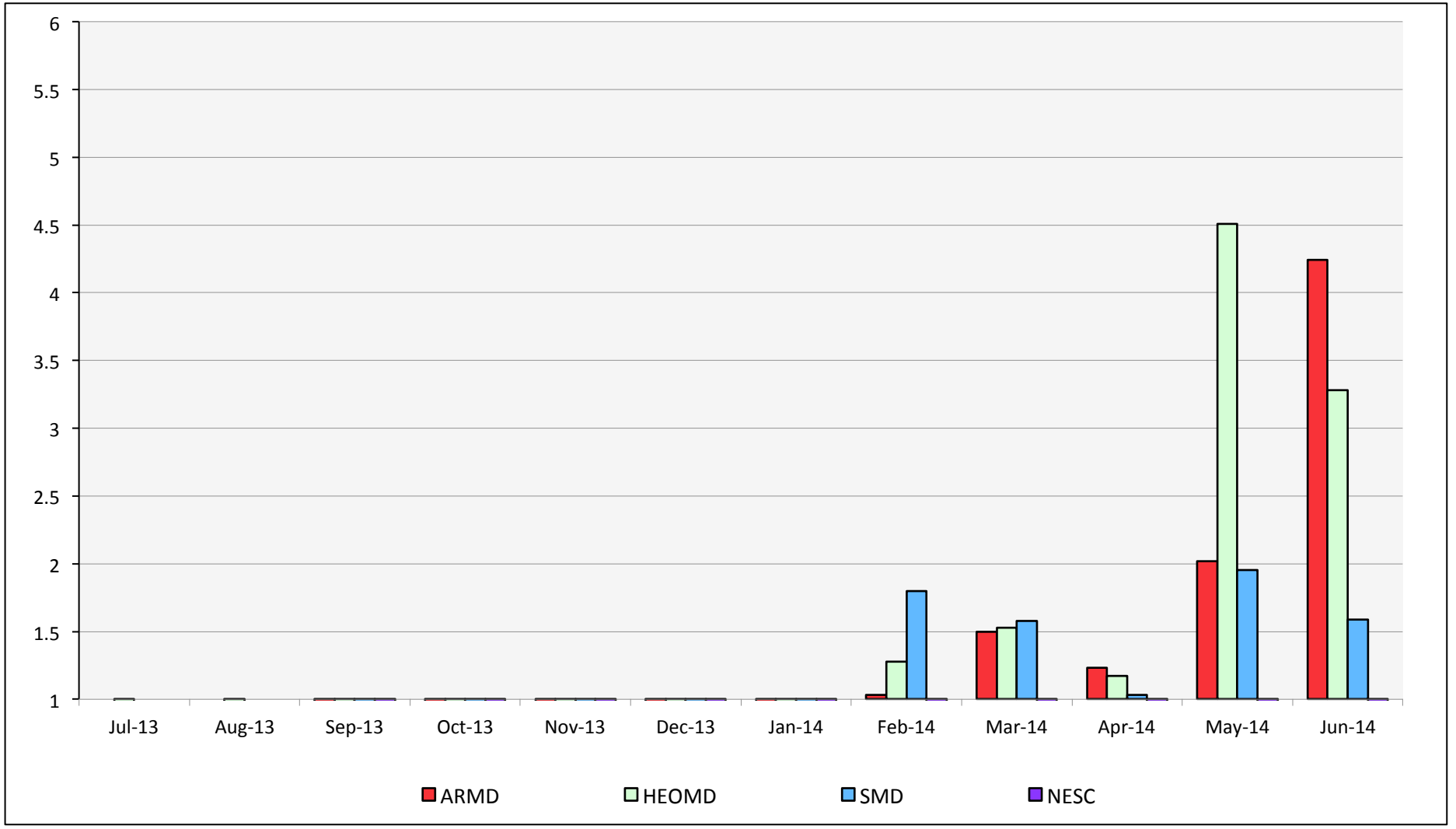
Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs



Endeavour:
Average Expansion Factor



Maia:
SBUs Reported, Normalized to 30-Day Month